REMARKS

Claims 1 to 44, as amended, and new claims 45 to 49 appear in this application for the Examiner's review and consideration. The new claims and the amendments are fully supported by the specification and claims as originally filed. In particular, support for the recitations in the claims of the transport of particles generally in the average direction of the field and the average direction of the major flux component, the transport of particles in different directions, and outlets that are configured to accept particles of different sizes and transported in different directions may be found in the figures and the descriptions thereof in the present specification. Therefore, there is no issue of new matter. In addition, the amendments to the independent claims add recitations that elaborate on the structure of the presently claimed invention, and, thus, do not affect the scope of the claims. The amendments only further clarify the claimed invention.

Claims 10 to17 and 28 to 35 were rejected under 35 U.S.C. §102(e) as allegedly being anticipated by U.S. patent No. 6,762,059 to Chan, et al. ("Chan") for the reasons set forth on pages 2 to 4 of the Office Action. Applicants respectfully reserve their right to submit a Declaration under 37 C.F.R. §1.131 to establish invention of the subject matter of the subject claims prior to the effective date of the reference.

In response, Applicants submit that the presently claimed invention is directed to microfluidic devices and methods for separating particles according to size. The microfluidic devices of the invention comprise a microfluidic channel, and an ordered array of obstacles within the microfluidic channel. The devices employ a field that propels the particles being separated through the microfluidic channel, where the ordered array of obstacles is asymmetric with respect to the average direction of the field. When particles are introduced into the array, those particles having a size less than a predetermined critical size are transported in a first direction, and those particles having a size at least that of the critical size are transported in a second direction, where the first and second directions are different, thereby separating the particles according to size.

The method of the invention comprises introducing the particles to be separated into a microfluidic channel comprising an ordered array of obstacles, and applying a field to the particles to propel the particles through the microfluidic channel. The ordered array of obstacles

is asymmetric with respect to the average direction of the field. Particles having a size less than a predetermined critical size are transported in a first direction, and particles having a size at least that of the critical size are transported in a second direction, where the first and second directions are different, thereby separating the particles according to size.

To be anticipated, all of the elements of the present claims must be disclosed either expressly or inherently by a single prior art reference. A claim element is only inherent to a disclosure if it is a necessary result of the teaching of that disclosure. That is, it must occur each and every time the teaching of a prior art reference is practiced. M.P.E.P. 2131.01(III). The present Office Action does not expressly state that elements of the currently claimed invention are inherent to the disclosure of Chan. However, the Office Action alleges that array embodiments illustrated in Figure 3 of Chan are ordered arrays of obstacles that are asymmetric with respect to the average direction of the field. As none of the illustrations in Figure 3 illustrate a field or indicate a field direction, Applicants must assume that the Office Action is implying that this element of the claimed invention is inherently disclosed by Chan. As discussed below, the presently claimed asymmetry of the array and the field direction is not a necessary result of the teaching of Chan, and, thus, is not inherent.

In contrast to the presently claimed invention, Chan discloses methods and apparatus for the characterization of single polymers that are used to determine the velocity and length of the single polymer following elongation, Column 1, lines 12 and 13; column 4, lines 24 to 26, and 66 and 67. Chan does disclose arrays, as stated in the Office Action. However, Chan only discloses that the arrays are used to elongate the polymers. Column 29, lines 25 to 43.

Chan does not disclose anything regarding the arrangement of an array and the field direction, and, thus, fails to disclose that particles having a size less than a predetermined critical size are transported in a first direction, and particles having a size at least that of the critical size are transported in a second direction, when the array is asymmetric to the average direction of the field, as presently claimed. As clearly set forth in the present specification, it is this asymmetry that results in the transport of particles having different sizes in different directions, separating the particles.

Chan does not disclose that the arrays illustrated in Figures 3Bxv, 3Bxvii, and 3Bxviii are asymmetric with respect to the average direction of the field, as alleged in the Office Action at pages 2 and 3. In particular, Chan states specifically, at column 29, lines 25 to 58, that the

embodiment illustrated in Figure 3Bxvii is a funnel. The funnel clearly does not comprise an array, and, thus, that figure does not illustrate an array asymmetric to the direction of a field, as presently claimed. Moreover, none of the embodiments illustrated in Figure 3, including those cited in the Office Action, provide any field direction, and, thus, those figures do not disclose the presently claimed asymmetry of the array relative to the field direction. The Office Action would appear to assume that the direction of the field is from the side in Figure 3Bxv and from either the top or the side in Figure 3Bxviii. Such a field direction would be necessary for an asymmetric array, but no such field direction is disclosed. However, the array of Figure 3Bxv would be symmetric with a field having a vertical direction, and the array illustrated in Figure 3Bxviii would be symmetric with a field having a direction parallel to the alignment of the gaps in the array of that Figure. Therefore, an array of obstacles asymmetric to the direction of a field is not disclosed by Chan, is not a necessary result of the teaching of Chan, and is not inherent to Chan.

Moreover, the separation of particles in two different directions is not expressly or inherently disclosed by Chan. Starting at [0049] at page 13, the present specification teaches that, to separate particles according to size with the presently claimed invention, the misalignment factor, a, must be larger than 0 and less than 0.5. Only when the misalignment factor falls within that range is an array asymmetric to the average direction of the field, thereby providing the desired separation of particles. When the centers of the obstacles in the rows of the array are all aligned, $a = 0$. When the centers of the obstacles in one row of the array are aligned with the centers of the gaps in the next row $a = 0.5$. An array having a value of $a = 0$ or $a = 0.5$ is symmetric to the average direction of the field. Such an array is outside the scope of the present claims, and does not separate particles in the manner of the present invention.

One of ordinary skill in the art following the teaching of Chan, particularly based on the other drawings of arrays provided in that reference, would use an array of the type disclosed by Chan to stretch polymers prior to characterization. However, the disclosed arrays have a value of $a = 0$, for example, see Figures 4B and 4M, or a value of $a = 0.5$, for example, see Figures 4G and 4K. As stated above, such arrays will not separate particles in the manner of the invention. Therefore, separation of particles using an ordered array of obstacles that is asymmetric with respect to the average direction of the field is not a necessary result of the teaching of Chan.

Therefore, as Chan does not disclose all of the elements of the presently claimed invention, either expressly or inherently, the present claims are not anticipated by that reference. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claims 10 to 17 and 28 to 35 over Chan.

It should also be noted that new claims 46 and 48, which depend from claims 10 and 28, respectively, recite additional elements that Chan does not disclose or suggest. In particular, the new claims recite first and second outputs configured to accept particles transported in the first and second directions, respectively. Chan is directed only to the measurement of the length and velocity of polymers, not the separation of particles, and fails to disclose anything regarding the output of the polymers after the measurement. Accordingly, those claims are clearly patentable over Chan.

Claims 10, 13 to 17, 28 and 31 to 35 were rejected under 35 U.S.C. §102(b), as allegedly being anticipated by U.S. Patent No. 5,837,115 to Austin et al. ("Austin") for the reasons set forth on pages 4 and 5.

In response, as discussed above, the present claims require an ordered array of obstacles through which particles are transported by a field, where the ordered array is asymmetric with respect to the average direction of the field, and the particles are separated according to size by transporting particles having a size at least that of a critical size in a different direction from particles having a size less than the critical size. One of ordinary skill in the art, following the teaching of the present specification at [0048] would understand that an "ordered array" is "an array having a generally periodic or repeating spatial arrangement." Moreover, one of ordinary skill in the art would understand that the dictionary definition of an array is a generally regular arrangement.

In contrast to the presently claimed invention, Austin in Figure 14, as cited in the Office Action, and at column 19, starting at line 23, discloses a "percolating array" for the study of the motion of cells, such as human blood cells. The "percolating array", illustrated in Figure 14 is patterned as a maze. Column 19, lines 39 and 40. The "percolating array" comprises open areas, passageways, and dead ends. Column 19, lines 40 to 44. Just one passageway leads through the "percolating array;" all other passageways lead to dead ends. Column 19, lines 57 to 59.

Clearly, the "percolating array" illustrated in Figure 14 is not an ordered array of the presently claimed invention. There does not appear to be anything regular about the arrangement

of the "percolating array," and there is nothing periodic or repeating about the arrangement of obstacles in the "array". Moreover, as there is only one passageway through the "percolating array," such an array cannot be used to transport particles in separate directions through the array that separate the particles according to size, as presently claimed.

Austin also discloses macromolecule fractionation, such as the fractionation of DNA molecules. Columns 8, lines 38 to 49. The molecules become hooked and trapped on obstacles in an array, separating small molecules, which pass through the array, from larger molecules that become trapped on the posts. Column 13, lines 42 to 55, and Figure 6. Cup-shaped obstacles may also be used to trap microstructures in the array.

Therefore, Austin does not disclose transporting particles having a size less than a predetermined critical size in a first direction and particles having a size at least that of the critical size in a second direction with a field, where the two directions are different, thereby separating the particles according to size. Instead, Austin discloses fractionating molecules by trapping them within an array.

Therefore, as Austin does not disclose all of the elements of the presently claimed invention, the claims are not anticipated. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claims 10, 13 to 17, 28 and 31 to 35 under 35 U.S.C. § 102(b) over Austin.

It should also be noted that new claims 46 and 48, which depend from claims 10 and 28, respectively, recite additional elements that Austin does not disclose or suggest. In particular, the new claims recite first and second outputs configured to accept particles transported in the first and second directions, respectively. Although Austin discloses the separation of molecules based on size, Austin fails to disclose anything regarding the output of the polymers in the manner of the presently claimed invention. Accordingly, those claims are clearly patentable over Austin.

Claims 1 to 9 and 18 to 27 were rejected under 35 U.S.C. §103(a) as allegedly being anticipated over Austin for the reasons set forth on pages 6 to 10 of the Office Action.

In response, Applicants submit that the presently claimed invention is directed to microfluidic devices and methods for separating particles according to size. A device of the invention comprises a microfluidic channel, and an array comprising a network of gaps within the microfluidic channel. The device employs a field that propels the particles being separated

through the microfluidic channel. A flux of the field from the gaps is divided unequally into a major flux component and a minor flux component into subsequent gaps in the network, such that the average direction of the major flux components is not parallel to the average direction of the field. When particles are introduced into the array, particles having a size less than a predetermined critical size are transported generally in the average direction of the field, and particles having a size at least that of the critical size are transported generally in the average direction of the major flux component, thereby separating the particles according to size.

The method of the invention comprises introducing the particles to be separated into a microfluidic channel comprising a network of gaps within the microfluidic channel, and applying a field to the particles to propel the particles through the microfluidic channel. A flux of the field from the gaps is divided unequally into a major flux component and a minor flux component into subsequent gaps in the network, such that the average direction of the major flux components is not parallel to the average direction of the field. Particles having a size less than a predetermined critical size are transported generally in the average direction of the field, and particles having a size at least that of the critical size are transported generally in the direction of the major flux component, thereby separating the particles according to size.

In contrast to the statement on page 7 of the Office Action that "Austin discloses arrays in which 'a flux of the field from the gaps is divided equally into subsequent gaps (embodiments in Figures 7 and 8, for example) or unequally into subsequent gaps (embodiment shown in Figure 14),'" Austin never uses the term "flux," and clearly fails to disclose anything regarding the division of such a flux of the field. Clearly, the embodiments illustrated in Figures 7 and 8 are outside the scope of the present claims, as is the embodiment illustrated in Figure 6. Those embodiments, as stated in the Office Action, illustrate arrays in which the "a flux of the field from the gaps is divided equally into subsequent gaps."

Moreover, as discussed above, the embodiment illustrated in Figure 14 is a "percolating array." Austin discloses that such a "percolating array" has only one passageway through the maze of the "array." As all particles that pass through such an "array" must follow the same passageway, such an "array" cannot separate particles according to size, as presently claimed.

The Office Action, at page 7, also states that configuring that array to provide the presently claimed unequal division of the field into major and minor flux components is "just a

matter of optimizing the array for the particles to be separated." That is, an array of the presently claimed invention is "an obvious optimized configuration."

However, as stated in the Office Action, Austin does not disclose or suggest anything regarding the division of the flux of the field. Therefore, Austin fails to provide any motivation to one of ordinary skill in the art to alter the illustrated arrays to divide the flux unequally to obtain the presently claimed invention.

Therefore, as Austin does not disclose or even suggest the presently claimed invention, and fails to provide any motivation to obtain the present invention, the claims are not obvious over that reference. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claims 1 to 9 and 18 to 27 under 35 U.S.C. § 103(a) over Austin.

It should also be noted that new claims 45 and 47, which depend from claims 1 and 18, respectively, recite additional elements that Austin does not disclose or suggest. In particular, the new claims recite first and second outputs configured to accept particles having at least the predetermined critical size and particles smaller than the predetermined critical size, respectively. Although Austin discloses the separation of molecules based on size, Austin fails to disclose anything regarding the output of the polymers in the manner of the presently claimed invention. Accordingly, those claims are clearly patentable over Austin.

Claims 36 to 44 were rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Chan for the reasons set forth on pages 10 and 11 of the Office Action.

In response, Applicants submit that the presently claimed invention is directed to a microfluidic device for separating particles according to size, comprising a microfluidic channel, and multiple arrays in series within the microfluidic channel. Each array has a different critical size, and the device employs a field that propels the particles being separated through the microfluidic channel. Each array comprises a network of gaps. A flux of the field from the gaps is divided unequally into a major flux component and a minor flux component into subsequent gaps in the network, such that the average direction of the major flux components in each array is not parallel to the average direction of the field. When particles are introduced into an array in the series, particles having a size less than the predetermined critical size of the array are transported generally in the average direction of the field, and particles having a size at least that of the critical size of the array are transported generally in the average direction of the major flux component, thereby separating the particles according to size.

In contrast to the presently claimed invention, as discussed above, Chan discloses methods and apparatus for the characterization of polymers. Chan does not disclose or suggest separating particles according to size, and clearly fails to disclose or suggest dividing the flux of a field unequally with an array. As noted in the Office Action, none of the arrays in the embodiment illustrated in Figure 4H of Chan comprises a network of gaps in which the flux of the field is divided into major and minor components that transport particles of different sizes, as presently claimed.

However, the statement in the Office Action that Chan discloses configurations of arrays configured with gaps in which the flux of the field is divided unequally, such as that illustrated in Figure 3Bxvii, is clearly incorrect. As discussed above, the embodiment illustrated in Figure 3Bxvii is a funnel that does not comprise an array. In addition, as with the embodiment of Chan illustrated in Figure 3Bxvii, many of the other structures for stretching polymers illustrated in Figure 3, and described at column 29, line 25 to column 30, line 24, as cited by the Office Action, do not comprise arrays. Moreover, none of the arrays illustrated in Figure 3 illustrate a field or indicate the direction of a field, and, thus, Chan fails to disclose or suggest that such arrays should be configured to divide the flux of a field unequally. Therefore, Chan fails to provide any motivation to configure any of the disclosed arrays relative to the direction of the field in the manner required to obtain the presently claimed invention.

Moreover, as discussed above, in those devices illustrated in Figure 4 by Chan in which the arrangement of the array relative to the likely direction of the field can be determined, the value of the misalignment factor, a, is 0 or 0.5, placing those embodiments outside the scope of the present claims. Therefore, one of ordinary skill in the art following the teaching of Chan would not obtain an array that divides the flux of the field unequally into major and minor flux components, and would not observe or recognize any unequal division of the flux.

Therefore, as Chan does not disclose or even suggest the presently claimed invention, and fails to provide any motivation to obtain the invention, the present claims are not obvious over that reference. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claims 36 to 44 under 35 U.S.C §103(a) over Chan.

It should also be noted that new claim 49, which depends from claim 36, recites additional elements that Chan does not disclose or suggest. In particular, the new claim recites that a last array in the series comprises at least one output configured to accept particles

transported in the average direction of the major flux component of at least one array in the series. Chan is directed only to the measurement of the length and velocity of polymers, not the separation of particles, and fails to disclose anything regarding the output of the polymers after the measurement. Accordingly, new claim 49 is clearly patentable over Chan.

Applicants thus submit that the entire application is now in condition for allowance, an early notice of which would be appreciated. Should the Examiner not agree with Applicants' position, a personal or telephonic interview is respectfully requested to discuss any remaining issues prior to the issuance of a further Office Action, and to expedite the allowance of the application.

The fee for the new claims is believed to be $125.00, as Applicants' assignee is a small entity. Separate Petition for Extension of Time and Claim Fee sheets are attached. Please charge any additional fees that may be required to Deposit Account No. **11-0600**.

Respectfully submitted,

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